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THE PROPAGATION OF PLANTS.

BY

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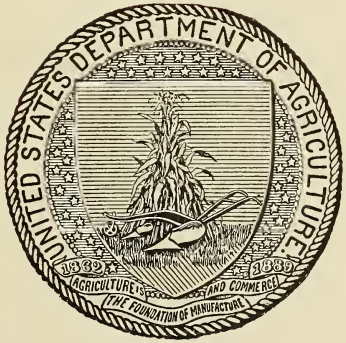

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Washington, D. C., October 22, 1909.

Sir: I have the honor to submit a paper on the Propagation of Plants, prepared by L. C. Corbett, Horticulturist of this Bureau, and to recommend its publication as a Farmers' Bulletin. This paper is a revision and enlargement of a paper on Nursery Hints, prepared by the same writer while horticulturist of the West Virginia Experiment Station, and published as a bulletin of that station.

The treatment of the subject is brief, simple, and practical, rather than complete and technical. It is believed that its publication as a Farmers' Bulletin will tend to assist and encourage farmers in the propagation of plants for their own use, especially small fruits, grapes, and orchard fruits. New illustrations have been made for figures 5, 6, 17, 21, and 22; otherwise no alterations have been made in the original edition of July 15, 1902.

Very respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE PROPAGATION OF PLANTS.

INTRODUCTION.

The propagation of plants is their reproduction by natural or artificial means. A knowledge of these means is of great importance to agriculturists of all classes, and especially to those engaged in the various branches of horticulture. There are, for instance, so many benefits to be gained by the local production of nursery stock that fruit growers of a developing region can not afford to neglect this art. The introduction of dangerous pests can be avoided, scions and buds from trees thoroughly acclimated can be obtained, the young stock will not be forced to suffer the shock of long transportation and a change of climate, and last, and by no means least, the orchardist can have his trees grown from scions or buds from his favorite trees.

MEANS BY WHICH PLANTS ARE REPRODUCED.

The means by which plants in nature reproduce their kind are seeds, spores, rootstocks, stolons, suckers or root sprouts, bulbs, corms, and tubers.

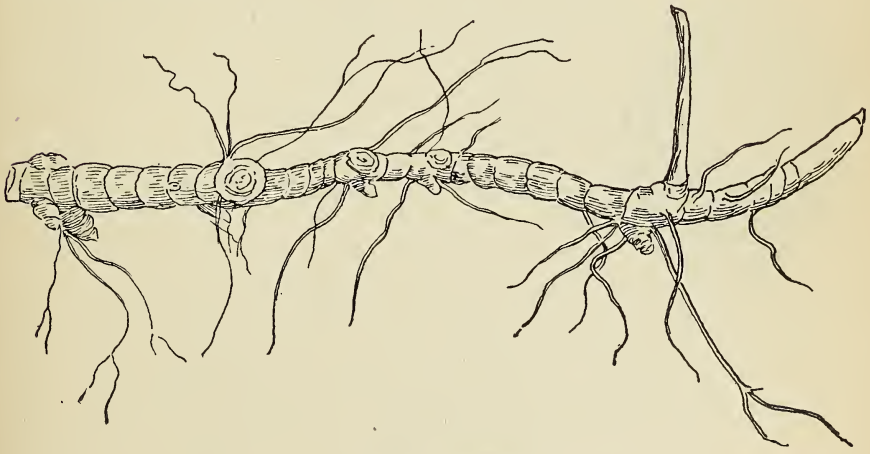

FIG. 1.—A rootstock.

By these means nature has provided for the perpetuation of species, for the continuance of general types. But man endeavors to reproduce the peculiar desirable qualities found in a single individual, and to multiply the number of individuals possessing these qualities. Therefore, in addition to using the natural means of reproduction,

man has developed several artificial means of reproducing plants, of which the principal are cuttings, layering, grafting, and budding.

Rootstocks.—Many species of plants, including a number of common grasses, spread by means of vigorous, fleshy rootstocks (fig. 1), which push out laterally in all directions from the parent plant, developing

FIG. 2.—Reproduction by means of stolons.

rootlets and throwing up the stems of new plants at intervals. Johnson grass and Bermuda grass are excellent examples of plants which spread in this manner.

Stolons.—Some plants throw out trailing branches or runners which take root at their ends or at joints, thus producing new plants (fig. 2). The strawberry is an excellent example of this class. Black raspberries reproduce in a very similar way, as the tips of the drooping canes readily take root when they touch the ground.

FIG. 3.—A bulb.

Suckers and root sprouts.—Many plants reproduce by means of suckers and sprouts sent up from lateral roots.

Nursery practices are greatly facilitated by this natural tendency in plants which reproduce their kind true to variety, as do the red raspberry and blackberry and some plums.

In general, seedlings and all plants that have been grown from cuttings will come true from root sprouts if they reproduce in that way. Outside the bush fruits, however, this method of reproduction should be discouraged rather than encouraged. Nothing is more annoying to the orchardist and fruit grower than the persistent sprouting of some plants.

Bulbs and corms.—A bulb (fig. 3) is a short rudimentary axis encased in more or less close-fitting fleshy leaves or bulb scales, in which is stored up nutriment to be used in subsequent growth. It is, in fact, a more or less permanent and compact leaf bud throwing out roots from its lower portion. Bulbs usually form at or just beneath the surface of the ground. They may be divided into two general classes,

(1) those composed of scales which are more or less narrow and loose, as in the lily, and (2) those composed of more or less continuous and close-fitting layers or plates, as in the onion. Bulbs often divide naturally into two or more parts, or may be so divided artificially, each of which parts serves the purpose of a complete bulb in propagation. Small bulbs or *bulbels*, sometimes called "daughter" bulbs, develop around the large or "mother" bulb, and are used in propagation. Bulbs are often caused to produce these bulbels artificially by wounding or mutilating them. A *bulblet* is a small bulb borne entirely above ground in the axil of a leaf or at the top of a stem, as in case of the "sets" of the onion.

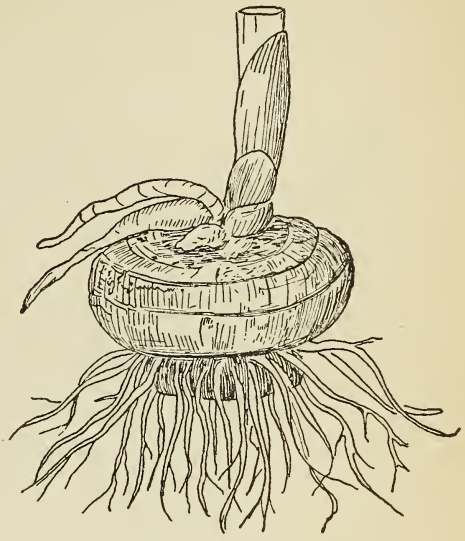

FIG. 4.—A corm.

A *corm* resembles a bulb in appearance (fig. 4), but differs from it in being solid throughout. Small corms, or *cormels*, are developed in very much the same manner as are daughter bulbs. Examples of corm-producing plants are the indian turnip, crocus, gladiolus, and caladium.

PROPAGATION BY MEANS OF SEEDS.

In a state of nature most species of plants depend mainly on seeds for the reproduction of their kind. Almost all plants which reproduce by other means also produce seeds. As a rule plants produce annual crops of seeds which, when mature, fall from the parent plant to the ground, often being carried in their descent considerable distances by the wind. Seeds are also carried by running water and by animals. A single plant produces a large number of seeds, sometimes an enormous number, so that the loss of a very large percentage by various natural means will not endanger the perpetuation of the species.

As seeds are the main dependence of plants in nature, so are they man's chief reliance in agriculture. The principal food crops of the world are grown from seeds planted by man.

The simplest and most common method pursued by the agriculturist is to prepare the soil and place in it the seeds of the future crops just where they are expected to grow and produce mature plants. This is

the method employed in growing cereals, cotton, most forage crops, and many truck and garden crops as well as ornamental plants.

With many cultivated plants, however, the seeds are planted in a bed, cold frame, hotbed, or greenhouse, and the plants, on reaching proper size, are transplanted to field or garden.

Nearly all orchard trees come from seeds originally planted in nursery beds and later, after being budded or grafted, transplanted to the orchard. They are in fact usually transplanted once or more before being finally put out in the orchard.

Seeds are sometimes soaked in water to soften the seed coats and start the process of germination. Seeds of many forest and fruit trees require special treatment to insure prompt germination. This treatment, known as stratification, consists in placing layers of seeds alternating with layers of sand in a shallow box. This box may be buried or it may be set in a sheltered place and covered with leaves or straw to the depth of a foot. The object is to soften and decay the hard covering without starting germination. Freezing is beneficial in case of walnuts, hickory nuts, peach pits, and the like, as it helps to crack the shells. Hence such seeds are sometimes stratified in boxes placed in sheltered spots on the surface of the ground, or they may be merely placed in a pile on the ground with a slight covering of leaves or straw.

A special point to be guarded against in stratification is alternate freezing and thawing. When once frozen the seeds should not thaw out until settled weather has arrived. Repeated freezing and thawing while in a moist condition is destructive to most seeds.

Seeds receiving this treatment should be planted immediately upon being removed from stratification and before signs of growth appear. A few hours' exposure to wind and sun may prove disastrous.

Spores are not true seeds, but they are the means of reproduction of a great number of species, such, for instance, as ferns and the various fungi. Mushrooms are the most important class of cultivated plants which depend on spores for reproduction.

CUTTINGS AND THEIR USE IN PROPAGATION.

A cutting is a detached portion of a plant inserted in soil or in water for the purpose of producing a new plant. Cuttings may, for convenience of treatment, be divided into three classes, (1) hard-wood cuttings, (2) herbaceous or soft-wood cuttings, and (3) root and tuber cuttings.

HARD-WOOD CUTTINGS.

A hard-wood cutting is a cutting from the ripened wood of a deciduous plant of the present or a previous season's growth.

The cultivated plants most commonly propagated by the use of hard-wood cuttings are grape, currant, gooseberry, and cranberry (not

deciduous). Many ornamental shrubs, such as privet, tamarisk, hydrangea, etc., as well as some trees, such as the willows, poplars, and some conifers, can also be propagated in this way. From a commercial standpoint this method of propagation is one of the most important.

Forms of Hard-wood Cuttings.

Simple cutting.—The most common form of hard-wood cuttings is that usually employed in propagating the grape and currant (fig. 5, *a*). Such a cutting consists of a straight portion of a shoot or cane nearly uniform in size throughout and containing two or more buds. At the lower end it is usually cut off just below a bud, because roots develop

FIG. 5.—Cuttings: *a*, simple cutting; *b*, heel cutting; *c*, mallet cutting; *d*, single-eye cutting.

most readily from the joints. At the top it is usually cut off some distance above the highest bud.

The heel cutting.—A cutting of this form (fig. 5, *b*) consists of the lower portion of a branch, containing two or more buds, cut off from the parent branch in such a manner as to carry with it a small portion of that branch forming the so-called "heel."

The mallet cutting.—A cutting of this form is produced by severing the parent branch above and below a shoot, so as to leave a section of it on the base of the cutting (fig. 5, *c*).

The principal advantage in the use of heel and mallet cuttings lies in the greater certainty of developing roots. The principal drawback is that only one cutting can be made from each lateral branch.

Single-eye cuttings.—When it is desired to make the largest number of cuttings from a limited supply of stock, cuttings are made containing but one bud each (fig. 5, *d*). Such cuttings are commonly

started under glass with bottom heat either in greenhouse or hotbed. They may be set either in horizontal position with the bud on the upper side or perpendicularly. In either case the bud is placed about an inch below the surface of the ground in soil which should be kept uniformly moist.

Treatment of Hard-wood Cuttings.

Cuttings are usually made with two or more buds. The cuttings are made while the wood is dormant during the fall or early winter. As fast as made they are tied in bundles of 25 or 50 (butts all one way) and buried bottom end up in a trench and covered to a depth of 2 or 3 inches with sand or mellow soil. This protects the top buds from freezing and gives the butts the benefit of the warmth of the sun in the spring, thus stimulating root development. Cuttings may also be kept over winter in a cool cellar buried in sand, sawdust, or moss.

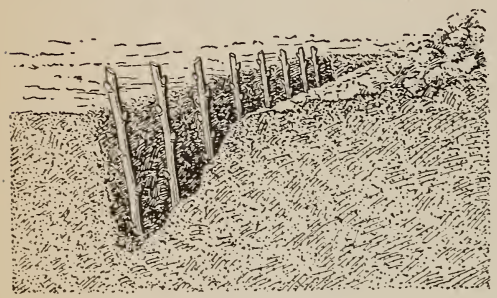

FIG. 6.—Cuttings set in trench.

The following spring the bundles are taken up and the cuttings set about 3 inches apart in a trench with only the topmost bud or buds above the surface of the ground (fig. 6). The soil is then replaced in the trench and thoroughly packed. In planting, the cuttings should be exposed to light and air as little as possible.

After being planted the cutting should develop roots and put forth leaves, and by the next fall or spring it should be ready to put out in the permanent plantation.

FIG. 7.—Leaf cutting—part of leaf.

HERBACEOUS OR SOFT-WOOD CUTTINGS.

This class of cuttings is exemplified in the "slips" used to increase the numbers of house plants. Many greenhouse plants, including roses, carnations, geraniums, chrysanthemums, fuchsias, begonias, and the like, are propagated in this way. This method of propagation can be employed in the winter time under glass. Near the large cities the propagation of ornamental plants for use on lawns or in parks, yards, and gardens has become an important and remunerative business.

Herbaceous cuttings may be made from the leaf or stem.

Leaf cuttings.—These are commonly employed in multiplying hoyas, begonias, and other plants having thick fleshy leaves containing a large quantity of plant food either in the body of the leaf or its larger ribs. Such cuttings may be made from parts of a leaf (fig. 7), or a whole leaf may be employed (fig. 8). In either case a leaf which has

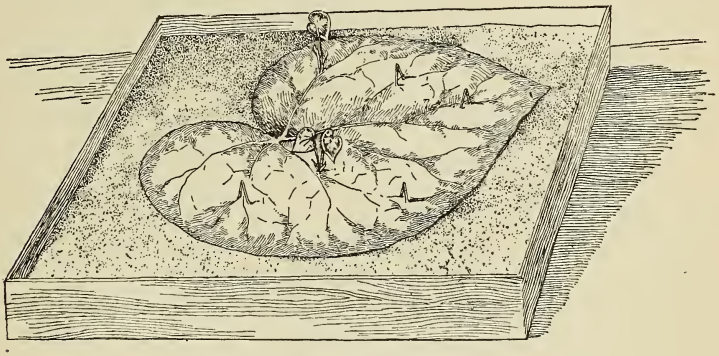

FIG. 8.—Leaf cutting—whole leaf.

reached its full development, and is in a vigorous, healthy condition, is essential. A suitable bed for the propagation of leaf cuttings may be made by filling a shallow box with fine clean gravel or sand. Soil containing considerable organic matter is to be avoided, also sand containing much clay. Material prepared artificially by crushing sandstone is often used. During winter months a few degrees of bottom heat will be found useful with leaf cuttings of most plants, and some can not be induced to strike root without it.

FIG. 9.—Stem cutting or "slip."

Stem cuttings.—A stem cutting or "slip" is a portion of a branch containing two or more nodes with leaves attached (fig. 9). Stem cuttings of coleus, geranium, and allied plants strike root very easily. As a general rule, in preparing slips the leaf area should be reduced to a minimum in order to lessen evaporation of the moisture contained in the cutting, and thus prevent wilting.

Methods and conditions.—Depth of the sand to be used in the propagating bed varies with the plants to be propagated, but usually an inch of broken stone or coarse gravel overlaid with 1½ to 3 inches of sand will be found amply sufficient for all soft-wood cuttings.

A confined atmosphere over the tops is especially required in propagating plants which have leaves that are thin and are liable to wilt easily; also for herbaceous cuttings which require a long period in which to form roots, and those from soft wood which suffer from exposure. Such a close atmosphere can be secured by means of a sash supported by a tight frame. The simplest device for use in a small way is the bell glass. Single cuttings may be covered with inverted glass jars.

If the trouble known as "damping off" develops in connection with this work, the sand should be removed, the inside of the box or frame should be scrubbed and whitewashed, and fresh sand should be put in.

TUBER CUTTINGS AND ROOT CUTTINGS.

Tuber cuttings.—Tubers (fig. 10) are thickened portions of either roots or stems in which starch is stored up. Irish and sweet potatoes are familiar illustrations of tubers. Roots do not commonly arise from the tubers themselves, but from the bases of young shoots or sprouts. When these sprouts have developed roots, they may be removed from the tuber cutting and planted, and the cutting will then send out new sprouts. This practice is sometimes employed with new

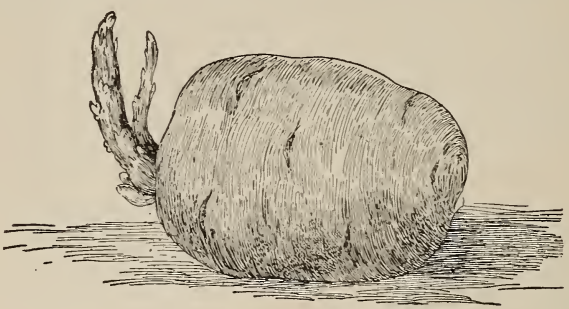

FIG. 10.—A tuber—Irish potato.

varieties of Irish potatoes in order to secure a maximum yield from a small stock of seed potatoes.

In cutting Irish potatoes, there should be at least one eye on each piece; but in cutting such tubers as sweet potatoes, which have no eyes, it is only necessary that each piece should have upon it a portion of the skin or epidermis from which adventitious buds may develop.

Tuber cuttings may be planted in hotbeds for the production of plants, which are then set out in the field or garden; or, as is customary with Irish potatoes, the cuttings may be planted in furrows in the field or plot which is to produce the crop.

Root cuttings.—Short cuttings of the roots may be used in the propagation of many plants, especially those which show a natural tendency to sucker. Rootstocks (fig. 1) of Johnson grass, Bermuda, and some other grasses can be cut into short pieces and used in setting fields to grass. With root cuttings of many plants bottom heat is useful, but root cuttings of the blackberry do well with ordinary outdoor treatment.

Horse-radish is propagated by root cuttings. The small lateral roots may be cut off and cut into pieces 4 inches in length and planted. Care should be taken to place them in the ground either horizontally or right end up. In order to avoid mistakes in placing the roots in the ground, cuttings may be made with a slanting cut at the base and a square cut at the top.

LAYERING.

A layer is a branch so placed in contact with the earth as to induce it to throw out roots and shoots, thus producing one or more independent plants, the branch meanwhile remaining attached to the parent plant. Layering frequently proves a satisfactory method of multiplying woody plants which do not readily take root from cuttings.

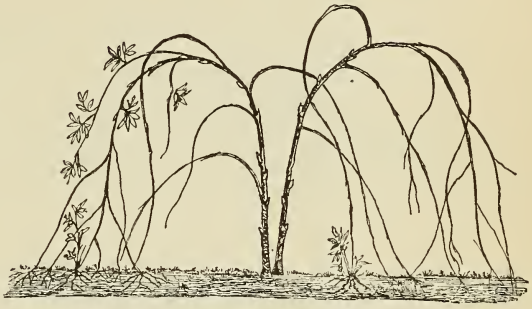

FIG. 11.—Tip layering.

Tip layering.—The tip of a branch or cane is bent down to the ground and slightly covered with soil, when it will throw out roots and develop

FIG. 12.—Vine layering.

a new plant (fig. 11). Many plants can be propagated in this way. The black raspberry is a familiar example.

Vine layering.—A vine is stretched along the ground and buried throughout its entire length in a shallow trench, or it may be covered

in certain places, leaving the remaining portions exposed. Roots will be put forth at intervals and branches thrown up. Later the vine may be cut between these, leaving a number of independent plants (fig. 12). The grape can be easily propagated in this way.

FIG. 13.—Mound layering.

Mound layering.—Plants which stool, sending up a large number of stems or shoots from a single root, are often layered by mounding up the earth so as to cover the bases of these stems and cause them to throw out roots (fig. 13). Each may then be removed from the original root and treated as an independent plant. A plant is often cut back to the ground to make it send up a large number of shoots to be layered in this way.

GRAFTING.

Were all forms of the art of grafting and budding to be taken from the horticulturist to-day, commercial fruit growing in its high state of perfection would decay with the orchards now standing.

Importance of grafting.—All the common pomaceous fruits (apples, pears, and quinces), the stone fruits (peaches, plums, cherries, and apricots), and the citrus fruits (lemons, limes, and oranges) are now multiplied by grafting or budding. The progress in plant breeding and the great rapidity with which new sorts are now disseminated could not be obtained without the aid of budding or grafting. Under existing conditions it is not necessary for the originator of a new sort of apple to give any thought to the question of fixing that type so it may be reproduced from seed; the method of reproducing the sort does not enter as a factor into his efforts to secure the desired variation. Grafting or budding has settled that long ago; but were it otherwise, horticulturists would be studying different problems, and the nurseryman would be more of a scientist than a manufacturer.

The scion and its treatment.—A scion is a portion cut from a plant to be inserted upon another (or the same) plant, with the intention that it shall grow. Except for herbaceous grafting the wood for scions should be taken while in a dormant or resting condition. The time usually considered best is after the leaves have fallen, but before severe freezing begins. The scions are tied in bunches and buried in

moist sand, where they will not freeze and yet will be kept cold enough to prevent growth. Good results often follow cutting scions in the spring just before or at the time the grafting is to be done. If cleft grafting is the style to be employed this practice frequently gives good results, but spring cutting of scions for whip grafting is not desirable, as not enough time is given for proper healing of the wound before planting time in the spring.

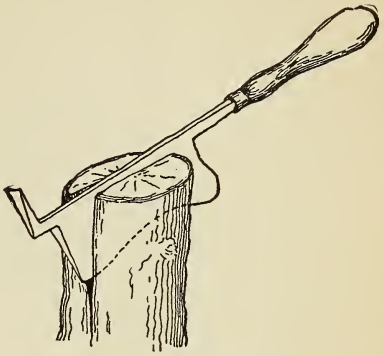

FIG. 14.—Grafting tool.

The stock and its treatment.—The stock is the plant or part of a plant upon which or into which the bud or scion is inserted. For best results in grafting it is essential that the stock be in an active condition, or so that active growth can be quickly brought about.

CLEFT GRAFTING.

This style of graft is particularly adapted to large trees when for any reason it becomes necessary to change the variety. Branches too large to be worked by other methods can be cleft grafted.

FIG. 15.—Cleft grafting: *a*, the scion; *b*, scions inserted in cleft.

A branch 1 or 1½ inches in diameter is severed with a saw. Care should be taken that the bark be not loosened from any portion of the stub. Split the exposed end with a broad thin chisel or grafting tool (fig. 14). Then with a wedge or the wedge-shaped prong at the end of the grafting tool spread the cleft so that the scions (fig. 15, *a*) may be inserted (fig. 15, *b*).

The scion should consist of a portion of the previous season's growth and should be long enough to have two or three buds. The lower end of the scion which is to be inserted into the cleft should be cut into the shape of a wedge, having the outer edge thicker than the other (fig. 16). In general, it is a good plan to cut the scion so that the lowest bud will come just at the top of this wedge (fig. 15), so that it will be near the top of

the stock. The advantage of cutting the wedge thicker on one side is illustrated in figure 16, which shows how the pressure of the stock is brought upon the outer growing parts of both scion and stock, whereas were the scion thicker on the inner side the conditions would be reversed and the death of the scion would follow. The importance of having an intimate connection between the growing tissues of both scion and stock can not be too strongly emphasized, for upon this alone the success of grafting depends. To make this contact of the growing portions doubly certain, the scion is often set at a slight angle with the stock into which it is inserted in order to cause the growing portions of the two to cross.

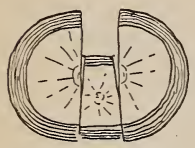

FIG. 16.—Cross section of stock and scion.

After the scions have been set the operation of cleft grafting is completed by covering all cut surfaces with a layer of grafting wax.

WHIP GRAFTING.

This style of grafting is the one almost universally used in root grafting. It has the advantage of being well adapted to small plants only 1 or 2 years of age, as well as the other great consideration that it can be done indoors during the comparative leisure of winter.

The graft is made by cutting the stock off diagonally—one long smooth cut with a sharp knife, leaving about three-fourths of an inch of cut surface, as shown in figure 17, *a*. Place the knife about one-third of the distance from the end of the cut surface, at right angles to the cut, and split the stock in the direction of its long axis. Cut the lower end of the scion in like manner (fig. 17, *b*), and when the two parts are forced together, as shown in figure 17, *c*, the cut surfaces will fit neatly together and one will nearly cover the other if scion and stock are of the same size. A difference in diameter of the two parts to be united may be disregarded unless it be too great. After the scion and stock have been locked together as shown in figure 17, *c*, they should be wrapped with five or six turns of waxed cotton to hold the parts firmly together.

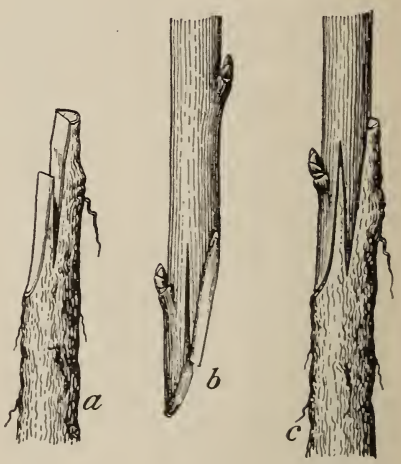

FIG. 17.—Whip grafting: *a*, the stock; *b*, the scion; *c*, stock and scion united.

While top grafting may be done in this way, it is in root grafting that the whip graft finds its distinctive field. When the roots are cut

into lengths of 2 to 5 or 6 inches to be used as stocks, the operation is known as piece-root grafting. Sometimes the entire root is used.

The roots are dug and the scions are cut in the fall and stored. The work of grafting may be done during the winter months. When the operation has been performed, the grafts are packed away in moss, sawdust, or sand in a cool cellar, to remain until spring. It is important that the place of storage should be cool, else the grafts may start into growth and be ruined, or heating and rotting may occur. If the temperature is kept low—not above 40° F.—there will be no growth except callusing, and the knitting together of stock and scion.

In ordinary propagation by means of whip grafts, the scion is cut with about three buds, and the stock is nearly as long as the scion. The graft is so planted as to bring the union of stock and scion not very far below the surface of the ground; but where the trees are required to be especially hardy in order to stand severe winters, and the roots used are not known to be so hardy as the plants from which the scions have been cut, a different plan is adopted. The scions are cut much longer and the roots may be cut shorter, and the graft is planted so deep as to cause roots to issue from the lower end of the scion. When taken up to be set in the orchard, the original root may be removed entirely, leaving nothing but the scion and the roots which have put forth from it. This is a common practice in preparing nursery stock for planting in the northern part of the Mississippi Valley.

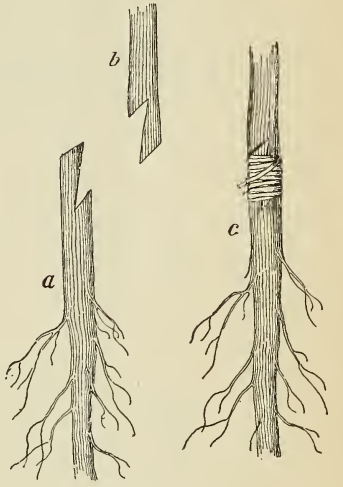

FIG. 18.—Veneer grafting: *a*, the stock; *b*, the scion: *c*, stock and scion united.

OTHER METHODS OF GRAFTING.

There are a great many other methods of uniting scion and stock, a few of which may be mentioned:

Bark grafting.—A branch is sawed off, as for cleft grafting, and the scions, instead of being inserted in a cleft, are cut very thin and slipped between the bark and wood, being inserted far enough to bring the growing parts together. The bark is then securely bound and wax is used as in cleft grafting. This is called crown grafting by the English and French. It is an excellent method for grafting larger limbs, as it injures the stock less than cleft grafting.

Splice grafting.—This is like whip grafting, except that no splitting is done, the sloping surfaces being simply placed together and tied.

Saddle grafting.—The stock is cut to a wedge shape and the lower

end of the scion is split and set upon the wedge, the place of union being tied and waxed.

Veneer grafting.—This method is illustrated in figure 18. The top of the stock is removed with an abrupt slanting cut. Then beginning at the highest portion of the top of the stock, cut a shaving which is thickest at its base and which can only be removed by a sloping cut, as shown in the illustration. Cut the lower end of the scion in like manner and bind the two firmly together with waxed string. When this style of graft is used as a root graft, no wax is necessary, but when used above ground the wound should be well covered. This method of grafting is adapted to use in either summer or winter.

FIG. 19.—A bud stick.

Shield grafting or scion budding.—The scion is cut very thin, as in bark grafting, and is inserted under the bark of the stock as a bud is inserted in the process of budding and is firmly bound in place with waxed cord or raffia (figs. 20, 21).

Side grafting.—The scion is cut wedge-shaped, as for cleft grafting, a chisel or a thick knife blade is forced into the stock, and the wedge of the scion is then forced into the incision. Waxed string and wax are then used.

GRAFTING WAX.

A good grafting wax may be made of the following ingredients: Resin, 4 parts; beeswax, 2 parts; tallow or linseed oil, 1 part—by weight. If a harder wax is needed, 5 parts of resin and 2½ of beeswax may be used with 1 part of tallow.

The resin and beeswax should be broken up fine and melted together with the tallow. When thoroughly melted the liquid should be poured into a vessel of cold water. As soon as it becomes hard enough to handle it should be taken out and pulled and worked until it becomes tough and has the color of very light-colored manila paper. If the wax is applied by hand, the hands should be well greased, tallow being the best material for this purpose. The wax may be applied hot with a brush, but care is necessary in order to avoid injury.

The wax should be spread carefully over all cut or exposed surfaces and pressed closely, so that upon cooling it will form a sleek coating impenetrable to air and moisture.

Waxed string may be prepared by putting a ball of No. 18 knitting cotton into a kettle of melted grafting wax. In five minutes it will be thoroughly saturated, after which it will remain in condition for use indefinitely.

BUDDING.

There are numerous styles of budding, but here the one in most common use will be described. Budding is one of the most economical

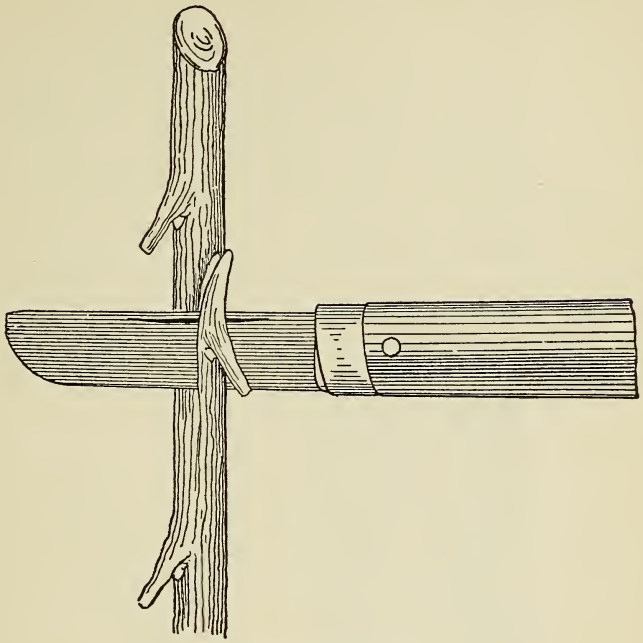

FIG. 20.—Cutting the bud.

forms of artificial reproduction, and each year witnesses its more general use. Some nurserymen have gone so far as to use it as a substitute for all modes of grafting, save whip grafting in the propagation of the dwarf pear. Budding is economical in the amount of wood used from which to take buds. In this method a single bud does the work of the three or more upon the scion used in grafting. But while it is economical of wood, it is expensive in the use of stocks, a seedling being required for each tree, while, with the piece-root system of grafting, two, three, or more stocks can be made from a single seedling.

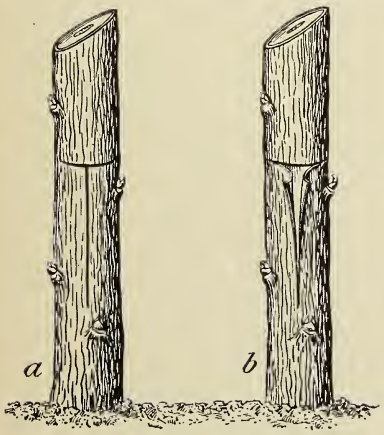

FIG. 21.—Budding—preparing the stock.

The operation of budding is simple and can be done with great speed by expert budders. The expense of the operation is, therefore, not more than that of whip grafting, although the work has usually to be done in July, August, or early

September. The usual plan is for a man to set the buds and a boy to follow closely and do the tying.

The bud.—The bud should be taken from wood of the present season's growth. Since the work of budding is done during the season of active growth, the bud sticks are prepared so that the petiole or stem of each leaf is left attached to serve as a handle to aid in pushing the bud home when inserting it beneath the bark of the stock. This is what is usually called a shield bud and is cut so that a small portion of the woody tissue of the branch is removed with the bud. A bud stick is shown in figure 19. The operation of cutting the bud is illustrated in figure 20.

The stock.—The stock for budding should be at least as thick as the ordinary lead pencil. With the apple and pear a second season's growth will be necessary to develop this size, while with the peach a

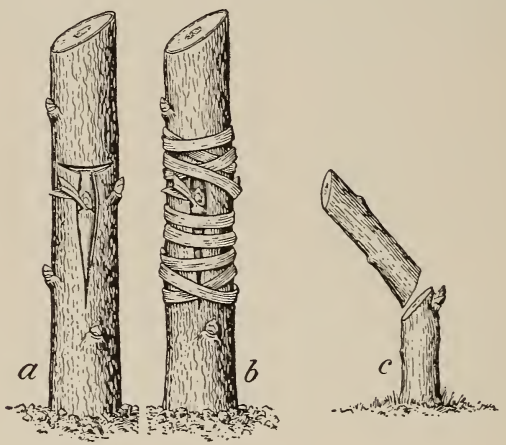

FIG. 22.—Budding: *a*, inserting the bud; *b*, tying; *c*, cutting off the top.

single season will suffice; hence peach stocks can be budded the same season the pits are planted. Consequently the peach is left until as late in the season as is practicable in order to obtain stocks of suitable size.

The operation.—The height at which buds are inserted varies with the operator. In general, the nearer the ground the better. The cut for the reception of the bud is made in the shape of a letter T (fig. 21, *a*). Usually the crosscut is not quite at right angles with the body of the tree, and the stem to the T starts at the crosscut and extends toward the root for an inch or more. The flaps of bark caused by the intersection of the two cuts (fig. 21, *b*) are slightly loosened with the ivory heel of the budding knife, and the bud, grasped by the leaf stem as a handle, is placed under the flaps and firmly pushed in place until its cut surface is entirely in contact with the peeled body of the stock (fig. 22, *a*). A ligature is then tightly drawn about, above and below the bud, to hold it in place until a union shall be formed (fig. 22, *b*).

Bands of raffia about 8 or 10 inches long make a most convenient tying material. As soon as the buds have united with the stock the ligature should be cut in order to prevent girdling the stock. This done, the operation is complete until the following spring, when all the trees in which the buds have "taken" should have the top cut off just above the bud (fig. 22, *c*).

Budding and grafting compared.—The removal of the top forces the entire strength of the root into the bud, and since the root itself has not been disturbed by transplanting a more vigorous growth usually results from the bud than from scions in whip or crown grafting.

The one objection to budding is that it causes an unsightly crook in the body of the tree unless the tree is planted deeply enough in the orchard to cover the deformity. In rigorous climates, where trees upon tender roots are likely to suffer from severe winters, a bud of a hardy sort upon a tender root is no hardier than the root, because budding leaves a portion of the stock exposed above the surface of the soil and thus precludes the possibility of the development of roots from the portion above the bud; while a piece-root-grafted tree with a long scion is practically the same as a tree propagated from a cutting, as the scion will strike root and the new plant will be upon its own root. In regions where severe winters do not enter as a factor there is undoubtedly a number of reasons why budding will be the most desirable method of reproducing horticultural varieties.